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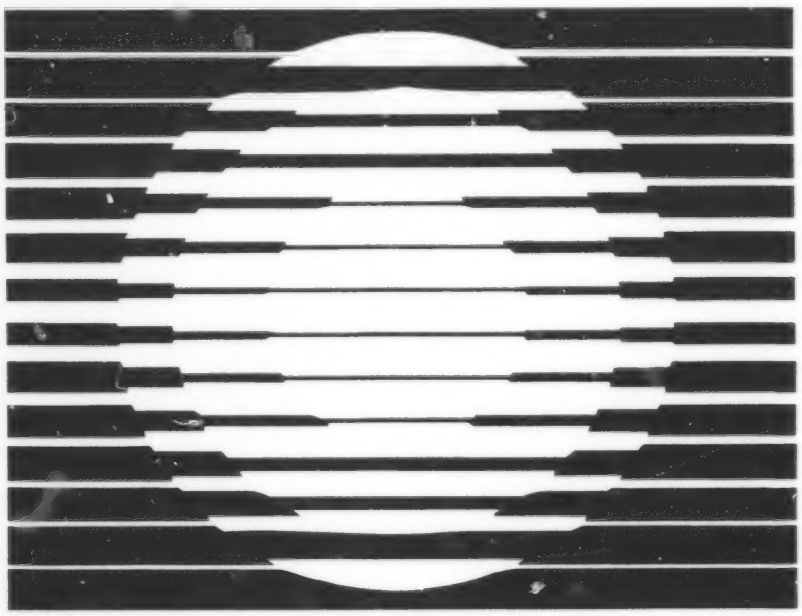
National Action Plan for Recovery, Recycling, and Reclamation of Chlorofluorocarbons (CFCs)



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October, 1992

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National Action Plan for Recovery, Recycling, and Reclamation of Chlorofluorocarbons (CFCs)

Prepared by the Federal Provincial Working Group
on Controls Harmonization (Ozone-depleting Substances)

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Abstract

This report develops the plan for essential recovery, recycling, and reclamation of chlorofluorocarbons(CFCs) for reuse in Canada to ensure that the large consumer and marketplace inventory of these compounds does not enter the atmosphere. Reuse is further necessary for future operation of equipment when production and importation of CFCs becomes severely restricted or is eliminated.

The report also deals with the need to recover hydrochlorofluorocarbons (HCFCs) for reuse. A harmonized national action plan containing a set of agreed-upon objectives and tasks is developed to provide a basis for federal and provincial programs, regulatory action, and data development.

Résumé

Le présent rapport décrit le plan visant la récupération, le recyclage et la régénération essentiels des chlorofluorocarbures (CFC) en vue de leur réutilisation au Canada, afin d'assurer que l'important stock commercial de ces composés ne soit pas libéré dans l'atmosphère. La réutilisation est d'autant plus nécessaire pour assurer le bon fonctionnement de l'équipement que la production et l'importation des CFC sont de plus en plus restreintes, voire éliminées.

Le rapport porte également sur le besoin de récupérer les hydrochlorofluorocarbures (HCFC) en vue de leur réutilisation. Un plan d'action national harmonisé contenant un ensemble d'objectifs et de tâches acceptés a été élaboré de façon à servir de base aux programmes fédéraux et provinciaux, aux mesures réglementaires et à l'élaboration des données.

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Executive Summary

The emission of ozone-depleting substances such as chlorofluorocarbons(CFCs) must be eliminated because of the stratospheric ozone depletion problem. A schedule for phasing out production of such substances has been established in the Montreal Protocol. Industry has developed some replacement compounds and continues to search for better ones. None of these, however, is commercially available in large quantities. For socio-economic reasons, phaseout is linked with the availability of alternatives.

In the meantime, CFC emissions can be greatly reduced by an effective nationwide CFC recovery, recycling, and reclamation program in the refrigeration and air conditioning industry. This industry uses more than 50% of all CFCs produced.

An effective recovery/recycle program and infrastructure for reclamation is critical to enable Canada to meet its commitment to phase out production and importation of virgin CFCs by December 31, 1995 while continuing to satisfy present and future service requirements for CFCs. An important part of the program will be to ensure that government requirements are consistent across all jurisdictions in Canada.

Regulatory and industrial infrastructures for "recovery/recycling/ reclamation" must not only be compatible, but must also be consistent with existing or revised standards used in the industry or those standards controlled by other authorities having jurisdiction. These needs are addressed in the National Action Plan.

The current situation in refrigeration and air conditioning is assessed in the National Action Plan in terms of emission generation, industry needs, and capability to implement change. A defined set of objectives for emission reduction is specified along with identifiable components of the necessary supporting infrastructure. There are no major barriers to "recovery/recycling/reclamation" that cannot be resolved.

Glossary

In this plan, the following definitions apply:

Ozone-depleting substance - A chemical compound that is sufficiently stable to reach the stratosphere and capable of reacting with stratospheric ozone, either directly or through release of a chemical element that reacts after the compound decomposes.

Chlorofluorocarbon (CFC) - A very stable compound containing chlorine, fluorine, and carbon atoms. Chlorofluorocarbons decompose in the stratosphere, releasing chlorine which reacts with ozone.

Hydrochlorofluorocarbon (HCFC)- A chemical compound that contains hydrogen, chlorine, fluorine, and carbon. Hydrochlorofluorocarbons are much less stable than CFCs, but small quantities can reach the stratosphere. The chlorine reacts with ozone in a similar manner to CFCs. They are considered acceptable as substitutes for CFCs for a transitional period of about 30 years, subject to review.

Hydrofluorocarbon (HFC)- A chemical compound that contains only hydrogen, fluorine, and carbon. Since no chlorine is present, these compounds have zero-ozone-depletion potentials and are ideal replacements for CFCs, environmentally and toxicologically, although they do have a small greenhouse effect.

Designated ozone-depleting - An ozone-depleting substance that is listed by name in the Montreal Protocol.

Disposable container - A container designed to be used only once for transportation or storage of CFCs or HCFCs; designed in accordance with BTC specification 39 (DOT 39 if made in the U.S.A.). There are two sizes: 13.6 kg and 22.3 kg.

Recovery - Collection of CFCs (or HCFCs) from equipment during servicing or before disposal (as opposed to venting to the atmosphere).

Recycling - Reuse of recovered CFC or HCFC refrigerants by charging back into the equipment after servicing. The refrigerant goes through some cleanup procedures before

return, e.g., filtering, drying. This is usually done at the job site but may be done off-site, depending on the volume.

Reclamation - Recovered refrigerants are shipped off-site to a central processing facility and cleaned by filtering, drying, distillation, and chemical treatment to meet industry accepted reuse standards or better. Results are verified by laboratory analysis.

The technical unit processes available for both recycling and reclaiming CFC refrigerants are essentially the same. In recycling, the unit processes used are generally less extensive and field test methods rather than analytical methods are used to verify quality.

White Goods - Household appliances such as refrigerators and freezers.

HRAI - Heating, Refrigeration and Air Conditioning Institute - An industry umbrella organization consisting of contractor associations, wholesaler associations, manufacturers, and individual companies. Its focus is to identify and resolve industry problems, liaise with regulatory authorities, provide education, and ensure industry standards.

RSES - Refrigeration Service Engineers Society - An organization of service technicians and contractors with wholesaler and manufacturer supplier members. Its primary focus is educational.

B 52 CODE - More correctly, "B52-M1991 Mechanical Refrigeration Code". This is a code of practice to ensure that adequate safety standards are consistently applied to refrigeration, air conditioning, and heat pump systems. It applies to the design, construction, installation, operation, and inspection of every refrigeration-related system. The Code does not have force of law until adopted by the provinces. It is generally in force across Canada.

B 52 CODE COMMITTEE - This refers to the "Technical Committee on Mechanical Refrigeration Code", which consists of the chief inspectors from each province, plus industry members, including representatives of manufacturers, users, contractors, insurance companies and HRAI.

B 51 CODE - More correctly, "Boiler, Pressure Vessel, and Pressure Piping Code". A code of practice to ensure adequate safety standards for all types of installations involving high pressure systems (greater than 15 psig design pressure.)

B 51 CODE COMMITTEE - This refers to the "Technical Committee on Boilers and Pressure Vessels". It consists of chief inspectors and members from a wide range of industries.

Section 1

Introduction

The purpose of this report is to describe a comprehensive National Plan of Action Program for implementating recovery, recycling, and reclamation (RRR) of ozone-depleting substances in Canada. To succeed, the program must be applied consistently across all jurisdictions in Canada.

The "Montreal Protocol on Substances that Deplete the Ozone Layer" was developed under the auspices of the United Nations Environment Programme (UNEP). The accord was revised in June 1990 to require a 100% global phaseout of CFC consumption (defined as Production plus Imports minus Exports) by the year 2000. At that time, Canada committed itself, along with 13 other countries, to a complete phaseout of virgin CFCs by 1997 (Environment Canada, 1991; Smale, 1991).

In response to recent findings on ozone layer depletion, Canada's Environment Ministers announced on March 18, 1992 that the phaseout of ozone-depleting chlorofluorocarbons (CFCs) will be accelerated and is to be completed no later than December 31, 1995. The Ministers also announced that all jurisdictions will begin implementing CFC recycling and recovery initiatives by the end of 1992.

This Action Plan will focus mainly on recovery, recycling, and reclamation of CFCs and HCFCs from refrigeration and air conditioning systems, but will also be suitable for application to other ozone-depleting substances and related operations. The establishment of the necessary infrastructure to facilitate recovery, recycling, and reclamation of both CFCs and hydrochlorofluocarbons(HCFCs) from systems and containers will be addressed.

Recovery, recycling, and reclamation play an essential role in emission reduction while at the same time ensuring a supply of necessary refrigerants, which will become increasingly scarcer and more costly, after production is phased out.

1.1 Definition of Terms

Ozone depletion has generated new science, new technology, and new compounds. Many new, or previously unused names and terms are now being employed. Understanding the precise meaning of many of these names and terms varies, depending on the individual's background.

Harmonized regulations for CFC recovery, recycling, and reclamation require that all technical terms have a precise meaning and are used consistently in that context. The appropriate terms are defined in the Glossary of this report.

1.2 The Need

Protection of the ozone layer is a global problem that requires an international solution. The Montreal Protocol was adopted in recognition of this fact, and now calls for a complete phaseout of CFC by the year 2000. Recent scientific data on ozone depletion indicate that CFC emissions must be reduced more effectively and rapidly than

previously recognized. Recovery and recycling of CFCs, which have been relatively unexploited until now, are a major means of significantly reducing CFC emissions immediately. Figure 1 shows the actual protocol phaseout and Figure 2 shows the possible area of effect from recovery, reycling, and reclamation (Environment Canada, 1990).

While alternative compounds or technologies for most uses of CFCs are, or will soon be available, chemical substitutes for some major use areas, in particular refrigeration and air conditioning, are not yet available in large marketable quantities. It is expected that they will be available, however, by 1993 or 1994. In the interim, CFCs will be required for new equipment and service requirements. Most of this equipment, particularly large commercial systems, will require CFCs for service throughout their useful lifetime which will continue past the year 2000. Continued use of CFCs for these essential purposes, while at reduced quantities, makes recovery, recycling, and reclamation vital to an effective emission reduction program.

At the same time, by reducing demand for virgin material, recovery, recycling, and reclamation will enable Canada to meet its commitment to phasing out production and importation of virgin CFCs by December 31, 1995 and still continue to satisfy service requirements for CFCs now and in the future.

Regulatory and industrial infrastructures for recovery, recyling, and reclamation must be compatible and consistent with existing or revised standards used in the industry or controlled by other authorities having jurisdiction. The National Action Plan addresses these needs.

The need for ultimate destruction of the "bank" when recycled CFCs are no longer required is being addressed separately. The roles and responsibilities of governments are also being examined. Inventory and use data determined under this plan will provide basic data for later use.

1.3 Background

As a result of the extensive development in stratospheric science and recent international recognition and agreements, protection of the ozone layer is a high priority for all jurisdictions in Canada. A number of provincial agencies and municipalities in addition to the federal government have initiated the development of control measures. In April 1989, the Canadian Council of Ministers of the Environment (CCME) directed the Federal-Provincial Advisory Committee (FPAC) of the *Canadian Environmental Protection Act* to coordinate the development of controls across all jurisdictions. This was intended to avoid the creation of a regulatory "patchwork quilt".

In June 1989, an Ad Hoc Working Group comprised of representatives from federal, provincial, and municipal governments was established to develop a strategy for harmonizing controls at all levels of government. The strategy and recommendations for its implementation have been completed, and were approved by CCME Deputy Ministers and Ministers in late November 1990.

At the second meeting of the Parties to the Protocol held in London, England from June 27 to 29, 1990, the federal Minister of the Environment announced a Canadian target of a complete phaseout of production

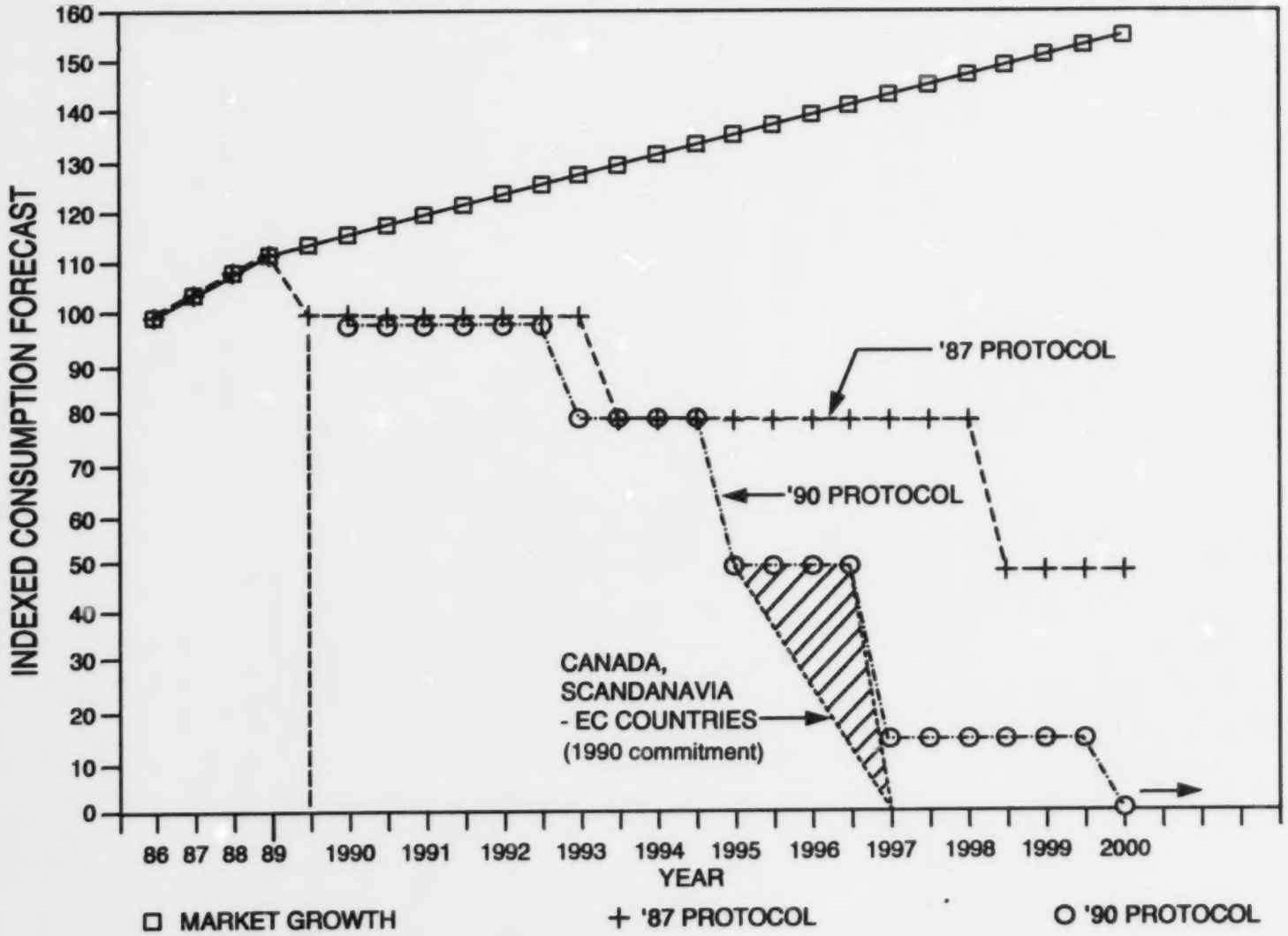

Figure 1 **Forecast Market Versus 1987 and 1990 Protocol**

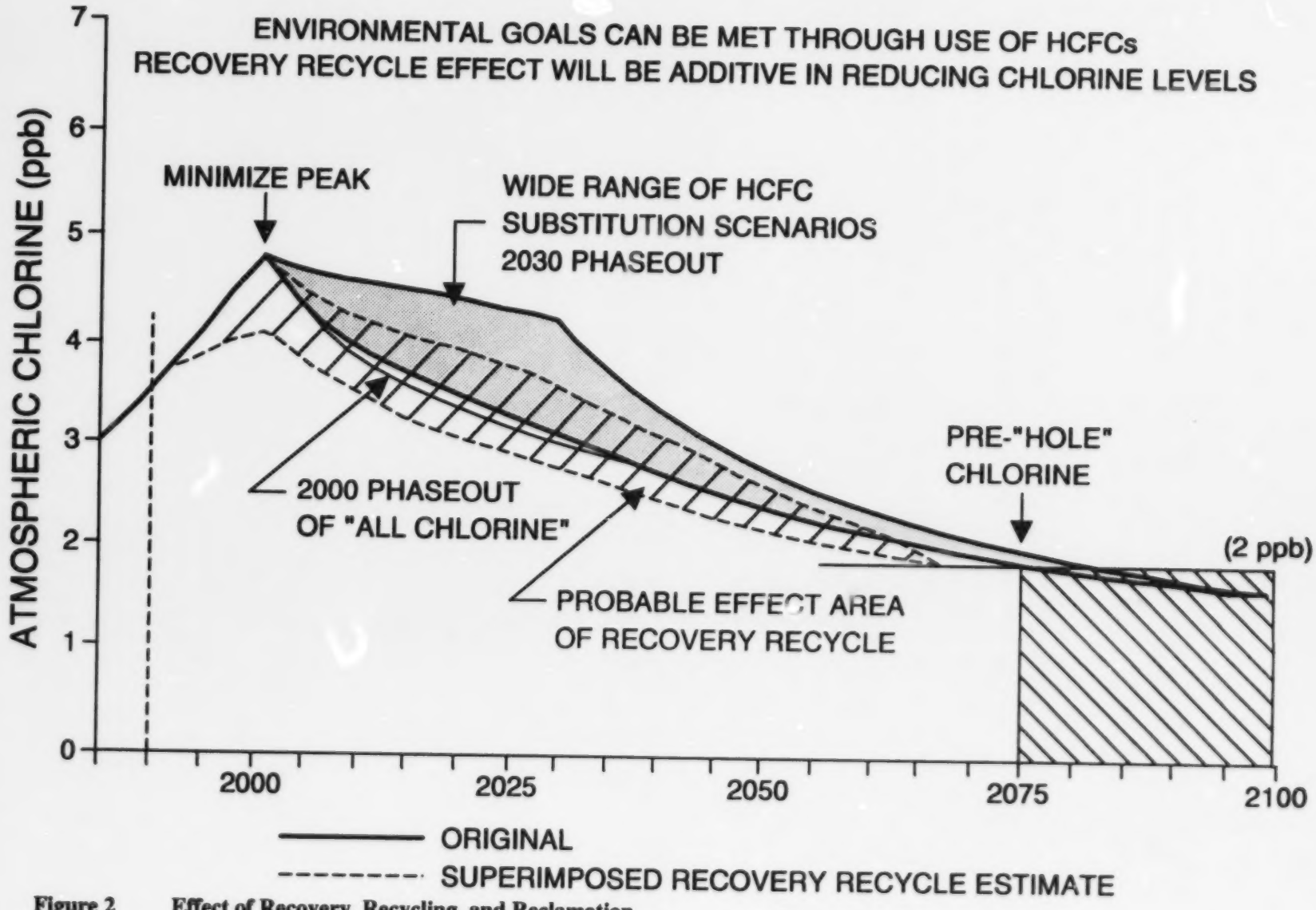

Figure 2 **Effect of Recovery, Recycling, and Reclamation**

and importation of virgin CFCs in Canada by 1997.

At their meeting on August 21, 1990, Deputy Ministers requested that the Ad Hoc Working Group develop an Action Plan for implementing recovery, recycling, and reclamation of CFCs across Canada.

At the March 18, 1992 CCME meeting, Ministers announced that all jurisdictions will begin implementing CFC recycling and recovery initiatives by the end of 1992. Ministers also emphasized that mandatory recovery and recycling programs must now become the focus of Canada's efforts to protect the ozone layer.

The Action Plan's objectives, tasks, and infrastructure are described in this report, which has been prepared by the Working Group, taking into account information received previously from producers and users of CFCs and trade associations. The report has not been subjected to a formal consultation involving industry, environmental groups, and other interested parties.

1.4 Objectives

An effective national CFC recycling action plan is critical for the federal government to achieve its stated objective of a complete phaseout in *consumption* of CFCs by December 31, 1995. This can only be done through the orderly management of the existing supply so that sufficient quantities of CFCs are available for essential uses while substitutes are brought to market. This includes the long-term service needs of existing equipment designed to use CFCs. The action plan should also provide recovery for ultimate destruction of CFCs when they are no longer required.

The action plan must be consistent in scope and timing across all jurisdictions in Canada, while allowing provinces the flexibility to deal with local issues.

The specific objective of the action plan is to reduce CFC emissions by:

- reducing demand for virgin CFCs by managing the existing supply;
- minimizing emissions of CFCs (and HCFCs) during installation, maintenance, repair, and disposal of equipment;
- establishing a regulatory infrastructure for recovery, recycling, and reclamation of CFCs and HCFCs in the near future, and ultimately, long-term destruction of CFCs;
- establishing the practice of recovering and recycling HCFCs through industry training; and
- reducing waste and venting of CFCs from containers.

The successful achievement of these objectives will require:

- incentives (e.g., economic, regulatory, codes, standards) to encourage recovery, recycling, and reclamation, adequate equipment design, and proper work practices;
- an industry-supported infrastructure to facilitate the recovery, safe transport, reclamation, and recycling of CFCs and HCFCs and ultimately the disposal of CFCs and HCFCs in an environmentally safe manner;
- a comprehensive plan to train the equipment service community and

sensitize the public to the need for recovery, recycling; and

- a comprehensive plan to involve building owners and managers in developing a strategic plan and policies to reduce and eliminate use and emissions of CFCs.

Section 2

Sources and Markets for Recycled and Reclaimed Chlorofluorocarbons

2.1 General

Chlorofluorocarbons are a family of similar compounds that are used in a variety of industries because of their low toxicity, inherent stability, and nonflammability. Their uses depend on the specific thermal and physical properties (e.g., boiling point and heat transfer coefficient) of the individual compounds.

Since their introduction to the marketplace, CFCs have been used in applications such as: refrigerants in heat pumps, refrigerators, and freezers; in air conditioners; propellants and slurrying agents in aerosols; blowing agents for plastic foam products and insulation; cleaning agents for metals, electronic equipment and components; carrier gases for sterilants for medical instrument sterilization; and as dry-cleaning fluids. Further details on the uses and applications of CFCs are presented in the Appendix.

Recycled and reclaimed CFCs are used primarily in refrigeration and air conditioning, as well as some solvent applications.

As a result of growing awareness and concern about the effects of CFCs on the ozone layer, development of replacement chemicals and alternative technologies has intensified. Demand for CFCs has declined as users have switched to environmentally acceptable alternatives or implemented some conservation and recycling practices.

Canadian consumption of CFCs for the first control period under the Montreal Protocol (July 1, 1989 to June 30, 1990) were 19% below the allowed 1986 levels, and dropped to 45% of the 1986 level in the following year. This trend will continue as more alternatives are brought to market, additional uses are eliminated through government regulations, and recovery, recycling, and reclamation are more widely practiced by industry.

It is important to know the quantities of CFCs that will become available for recycling or destruction in the future. A detailed study will be required to determine these values in order to develop demand forecasts with a degree of confidence. Consumption of CFCs in Canada was 20 300 tonnes in 1988. Use pattern for CFCs for 1988 is shown in Figure 3 and for 1990 in Figure 4.

2.2 Refrigeration and Air Conditioning Sector

Although CFCs may be recovered from other uses (e.g., solvent equipment), only those recovered from and reused in refrigeration and air conditioning equipment are addressed in this report. This sector provides significant quantities for recycling and, at the same time, a long-term requirement for reuse of CFCs.

In addition to recovery from refrigeration and air conditioning equipment during servicing and maintenance, it may also be

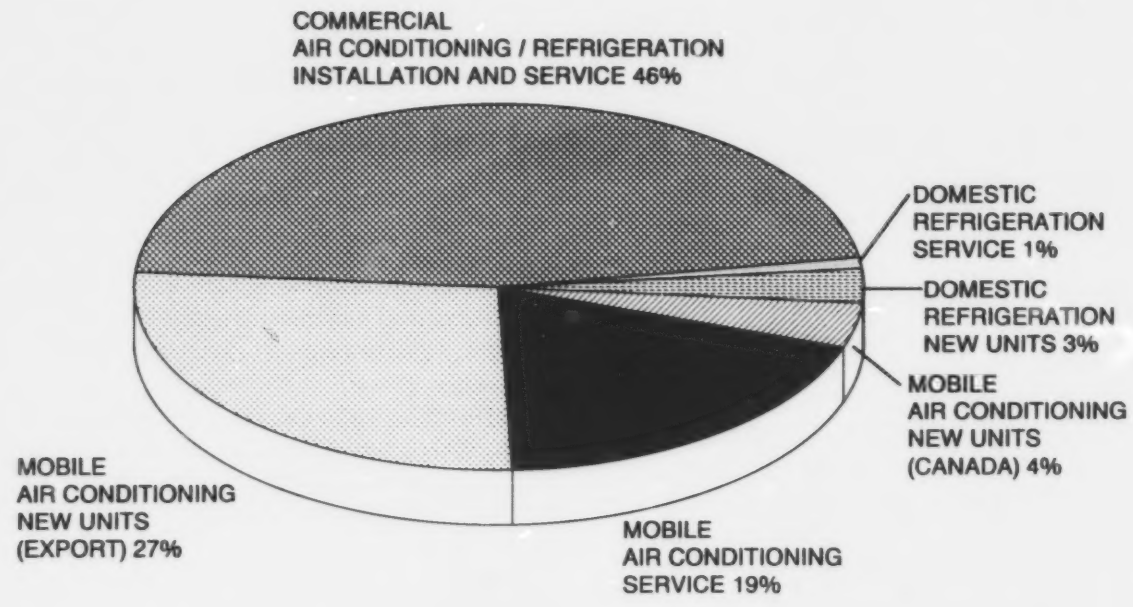

Figure 3 **Chlorofluorocarbons Used in Air Conditioning and Refrigeration-1988**
(Environment Canada, 1990)

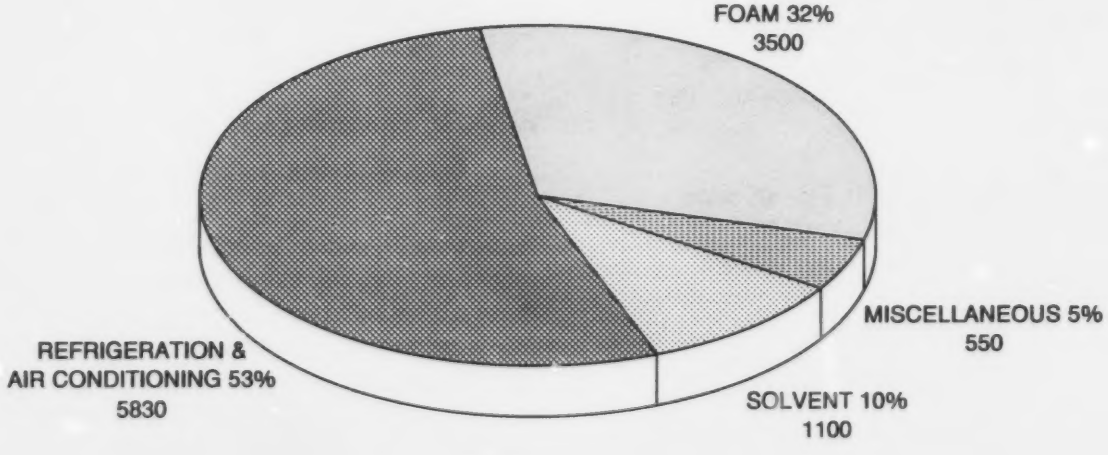

Figure 4 **Chlorofluorocarbons in Canada-1990**
(Environment Canada, 1990)

environmentally beneficial to recover CFCs from discarded equipment (e.g., curbside refrigerators, freezers, dehumidifiers, etc.) before disposal. This could include both refrigerants and insulation blowing agents.

For recycling, reclamation, or destruction, chlorofluorocarbons should also be recovered from systems before decommissioning, depending on the demand for CFCs at the time. Otherwise, they should be collected for destruction.

When available, CFC alternative replacement chemicals will be used in newly manufactured equipment. However, CFCs will still be required after 1995 to service older refrigeration equipment designed to use CFCs. Examples of such equipment may include:

- domestic refrigerators;
- mobile air conditioning units (cars, buses, trucks, trains, farm equipment);
- refrigerated transportation equipment (ships, containers, rail cars, trucks);
- industrial refrigeration units (major industry, industrial ice-making);
- commercial chillers (comfort air conditioners);
- cold storage/food refrigeration units (fish, food, vegetable freezers);
- retail refrigeration (supermarkets, refrigerator modules); and
- dehumidifiers.

Disposable cylinders (#30 [13.6 kg] and #50 [22.3 kg] sizes) are a major source of emissions and will require corrective action. This has already been initiated by industry through the introduction of a small, returnable container.

Section 3

Current Situation

3.1 Technologies

Chlorofluorocarbon refrigerants can be recovered from containers, equipment, or systems by using pumps, compressors (vacuum), recovery compressors which have condensers, or a combination of these.

Compressors in the refrigeration/air conditioning system can also be used to pump down the CFC to a recovery container. Ideally, the container should be part of the permanent system, but a portable container is also suitable.

Liquid refrigerants may be bled off the system into a recovery storage tank by balancing the vapour phase of each. Heating the condenser with hot water can expedite this.

Most commercial CFC recovery/recycling machines on the market use a compressor/evaporator/condenser arrangement to recover refrigerant and deliver it in liquid form to a storage container. It is virtually impossible to recover 100% of the refrigerant in a system using standard commercial equipment. Any such claims are highly doubtful. Recovered refrigerants should never be mixed.

Used CFC refrigerants may be contaminated by moisture (water), acids (hydrochloric; HCl), oil, noncondensable gases (mainly air), solids (debris/particulate) and sometimes, fluoride salts or carbonyl fluorides. If the contamination is within acceptable limits, the CFCs recovered can be charged right back to the system. Otherwise, certain cleaning processes are used to clean the CFCs. These may be of the recycling or reclaiming type.

Available technologies for recycling/reclamation (i.e., processes for cleaning the used CFC refrigerants) include distillation, filtration, drying, oil separation, and compression/condensation. In distillation, the CFC is separated from any nonvolatile foreign substances. With proper design and control, distillation may process the CFC to an acceptable purity. In filtration, the CFC is passed through a filter to remove the solids, while in drying, the CFC is passed through a desiccator to remove moisture. An oil separator is used to separate oil from the CFC. Chlorofluorocarbon recycling/reclamation usually employs a combination of these processes.

Chlorofluorocarbons are very difficult to separate because of their chemical similarity. They should never be mixed after recovery or reclamation. Recovery equipment should be checked before switching from one refrigerant to another, to ensure that no residual material is present.

It is also very important to ensure that no toxic or corrosive substances are mixed with recovered refrigerants.

About 24 companies in the United States, most of which have distributors in Canada, produce CFC refrigerant recovery/recycling machines. Several Canadian companies (five or six) have developed their own systems. These machines typically weigh

between 18 and 273 kg and cost between $1200 to $8000.

Most recycling machines are capable of removing some oil, acid, moisture, and particulate; and a few can eliminate noncondensable gases. Some machines are certified by U.S. Underwriters Laboratories Inc. (recognized by the United States Environmental Protection Agency; U.S. EPA) to meet SAE Standard J-1991, for use with automotive air conditioners (Smale, 1991). This standard is not applicable to stationary systems.

Union Carbide Canada and Ortech are developing a new recovery/reclamation technology for CFCs using a container with a molecular sieve inside to trap CFCs as the gas is passed through. The container is then returned to the manufacturer for CFC recovery and both CFCs and the molecular sieve material are reclaimed for reuse.

At present, there is no commercial-scale facility in Canada to reclaim CFCs recovered from refrigeration/air conditioning systems. Service contractors involved in this activity are either using small units and recycling the CFC refrigerants on-site, or sending the spent refrigerant to their wholesaler for return to the manufacturer who then does the required reclamation.

One of the two CFC manufacturers in Canada, Du Pont Canada, has introduced a collection network for recovered CFCs. It will also provide the necessary cylinders for service contractors to collect CFCs. Allied-Signal and Imperial Chemicals have also indicated they will accept used refrigerants for reclamation.

3.2 Control Initiatives: Refrigeration and Air Conditioning Systems

To date, initiatives to implement recovery, recycling, and reclamation of CFCs have been undertaken at all levels of government. Developments in this area are proceeding rapidly. A "snapshot" of what has occurred to date follows.

- *Environment Canada* - A "Code of Practice for the Reduction of CFC Emissions from Refrigeration and Air Conditioning Systems" (Environment Canada, 1991), recommends recovery of CFCs from all equipment during testing, servicing and before disposal (issued under the authority of the *Canadian Environmental Protection Act*; CEPA). Also, under the Environmental Stewardship program, it is proposed that all federal facilities recover/recycle CFCs when servicing their refrigeration/air conditioning units. Both Public Works Canada and National Defence have initiated actions.

- *Nova Scotia* - Regulations, which took effect July 1, 1991 (Nova Scotia, 1989) for mobile applications, and January 1, 1992 for stationary applications, require the recovery and recycling of CFCs from refrigeration, freezing, and air conditioning units both during servicing and prior to disposal. Training in recovery and recycling has also been initiated.

- *New Brunswick* - New Brunswick has developed an Ozone- Depleting Substances Regulation under its existing *Clean Environment Act* (New Brunswick, 1991). Consultation with industry is complete and the Regulation is expected to be finalized in June and be in effect by the end of August.

- *Quebec*- On April 30, 1992, the Quebec Minister of Environment publicly announced a first regulation on ozone-depleting substances (Quebec, 1992). This regulation covers the use, sale, recovery, and recycling of these substances. It will apply to CFCs, HCFCs, halons, methyl chloroform, and carbon tetrachloride. Recovery and recycling of CFCs and HCFCs used in refrigeration and air conditioning equipment will be mandatory. Sales to the public of halon portable fire extinguishers will be forbidden. The use of carbon tetrachloride and methyl chloroform, except in laboratories, will be forbidden effective January 1, 1995, and January 1, 2000, respectively. This regulation is in accordance with the schedule approved by the CCME in March 1992. The pre-publication period for the regulation started on May 6, 1992, and will allow concerned and interested stakeholders to comment; this period will last 60 days.

- *The City of Montreal* - In December 1989, the city announced that it would adopt the Code of Practice developed by Environment Canada for its own activities as well as for contracts with private firms. In addition, the method of transporting discarded refrigerators and freezers has been modified to avoid loss of refrigerant. A program of recovery and recycling from discarded units began in January, 1991. A test program to recover CFCs from foam is also underway.

- *Ontario* - Regulations effective July, 1991 (MOE, 1990) require recovery and recycling of CFCs generated through the service, installation, or disposal of mobile air conditioning systems, including refrigerated vehicles and rail cars. In addition, Ontario has amended its waste management Regulation 309 (MOE, 1990; 1988) to develop an infrastructure to track collection and movement of spent refrigerants for recycling. These amendments will help measure the effectiveness of CFC recycling programs.

- *The City of Toronto* - A bylaw requiring recovery and recycling of CFCs from equipment during servicing and the recovery of CFCs from white goods (residential refrigerators and freezers) before disposal came into effect April 1, 1991. Toronto has completed a pilot project involving recovery from scrap appliances (Toronto, 1990).

  A pilot study has been developed to assess servicing the metro Toronto municipalities with a network to handle old refrigerators and freezers. It will provide a service to recover CFCs from old equipment destined for landfill. The results of the study will provide information to help establish an inventory of equipment and stored CFCs, the effectiveness of pickup procedures, and the efficiency of a CFC recovery program for appliances.

- *Manitoba* - On July 1, 1992, Manitoba's Ozone-Depleting Substances Regulation and *Ozone-Depleting Substances Act* (Manitoba, 1992; Manitoba Environment, 1992) came into effect, making training, recovery and record-keeping mandatory for those working with designated CFCs and HCFCs. Manitoba Environment has taken steps to ensure a smooth implementation process. A province-wide training program based on the national Code of Practice was initiated in February 1992 to provide over 1500 technicians in all parts of the refrigeration and air conditioning industry with the opportunity to become qualified under the Regulation.

A Working Group on implementation made up of 12 industry and environmental representatives was established to identify implementation concerns, provide policy recommendations and review the Department's enforcement plans. A Co-ordinator for the Ozone-Depleting Substances Program has been added for 1992/1993.

- *The City of Winnipeg* - Manitoba Hydro, and the Province of Manitoba have undertaken a joint pilot project for the recovery and recycling of CFCs from domestic refrigators and freezers within the City of Winnipeg. The pilot project is expected to be completed in 1991 and results will be available in late 1992.

- *Alberta* - Draft regulations have been circulated for comment, and revisions to the draft regulations are in progress (Alberta, 1991). Alberta regulations are expected to be in place by fall, 1992. Alberta is currently conducting an inventory of specific ozone-depleting substances for the province. This inventory will also contain a forecast for reductions of specific ODSs.

- *British Columbia and Saskatchewan* - Draft regulations to mandate collecting, recovery, and recycling of CFC refrigerants are being prepared (Saskatchewan, 1991; British Columbia, 1991). Regulations are expected to be in place by fall 1992.

- *The Greater Vancouver Regional District (GVRD)* - A CFC control bylaw has been drafted; however, it is expected to be subsumed by provincial legislation. This legislation would prohibit the direct and indirect discharge of CFCs to the atmosphere from equipment during service, repair, and before disposal. Both Toronto and GVRD are involved in pilot projects to recover CFCs from discarded domestic refrigerators and freezers.

Section 4

Recommended Infrastructure for Recovery, Recycling, and Reclamation

The following are essential components of an effective infrastructure. Some of these may have to be implemented by regulation.

- incentives to recover and recycle CFCs;
- tracking system for movement and use of recovered material;
- standards and codes of practice regarding emission controls;
- education and communications;
- policy development and strategy planning by major building owners, especially governments; and
- development of an action plan for destruction of CFCs at the appropriate time to complement this recovery, recycling, reclamation action plan.

4.1 Incentives to Recover and Recycle Chlorofluorocarbons

The success of the Action Plan will depend on the extent of industry participation, and the fraction of the available "bank" of CFCs that is recovered and recycled.

Existing incentives to encourage industry participation in this activity include:

- Equipment manufacturers and servicing companies have a vested interest in securing adequate supplies of CFCs for servicing equipment as supply of virgin CFCs is reduced by regulation.
- Chlorofluorocarbon manufacturers want to retain their customer base as new chemicals are marketed, and therefore have an incentive to ensure that their customers have enough CFCs to do business during the process of market substitution.
- Effective emission reduction and lower chlorine levels in the stratosphere will reduce public pressure on the industry. Involvement in a recovery/recycling program can be a marketing plus.
- Servicing contractors want to maintain their customer base (building owners). If owners do not convert to new refrigerants, CFCs will be required to maintain service contracts.
- Owners of existing equipment will prefer to keep running on CFCs as long as possible. Conversion costs, cost of the new refrigerants, and loss of capacity and efficiency (energy costs) are important concerns to owners.

A nationally coordinated action plan will convince industry that governments are serious about recovery/recycling and encourage industry to proceed with the necessary investment. The following could provide further incentives.

- Government assistance (direct financial assistance, cost sharing, tax breaks, etc.)

could encourage industry (small companies, service outfits) to purchase recovery equipment.

- Government regulation could mandate recovery/recycling across all jurisdictions in Canada.

- Purchasing policies at all levels of government could be revised to specify that a certain percentage of recycled material be used when ordering CFCs to stimulate demand and encourage investment in necessary equipment.

- Inclusion of HCFCs in any incentive or regulation would be environmentally effective and broaden the opportunity base for equipment payback.

- Economic instruments can be effective tools in promoting environmentally sound behaviour. They can be less costly to administer than the traditional regulatory command and control approach. However, economic instruments can be complex to design and apply effectively. Governments may wish to give consideration to the applicability of economic instruments as an incentive to encourage recovery and recycling of CFCs and HCFCs.

4.2 Tracking System

As recovery and recycling increase, demand for virgin CFCs will decrease. Provinces and the federal government will want to track quantities of CFCs recycled and/or reclaimed to:

- monitor the extent to which recovery/recycling/reclamation is being practiced;

- facilitate enforcement of (future) regulations; and

- monitor inventories and the amounts that will ultimately have to be destroyed.

To assist in this task, it may be desirable for provinces to maintain an inventory of companies using, collecting, and storing CFCs in bulk. The existing network of CFC wholesalers or distributors will be used to collect and store used CFCs, under the current industry infrastructure for reclamation. Recycled material will have to be tracked through the equipment owners and service contractors.

4.3 Standards and Codes of Practice

Environment Canada has developed a "Code of Practice for the Reduction of Chlorofluorocarbon Emissions from Refrigeration and Air Conditioning Systems" which addresses such factors as: operational aspects, design, recovery, bulking, shipment, for recovery of CFCs, as well as disposal(Environment Canada, 1991).

Standards for performance of recovery and recycling equipment and acceptable purity of recyclable material will be required. Several standards have been developed, or are under development, in the United States (e.g., ARI Standard) (ARI, 1991).

Ideally, standards to ensure that equipment and systems design meets environmental requirements should be incorporated into the B-52 Refrigeration Code (CSA, 1991a). This would require transfer of the appropriate sections of the federal Code of Practice. Similarly, piping-related items should be put into the B-51 Refrigeration Piping Code (CSA, 1991b). This has been initiated.

Operating procedures and practice standards should be built into the Operating Engineer's Act in each province (e.g., Ontario) (Ontario, 1988).

Safety standards for recovery and recycling equipment are essential and should be referenced in the Code of Practice, as well as in industrial standards.

Quality standards for recycled or reclaimed material are an industry requirement and responsibility. Accepted industry standards should be supported and referred to in provincial regulations to avoid confusion concerning quality requirements.

4.4 Education and Communications

It is important to ensure that all users and handlers of CFCs are aware of the detrimental effect CFCs have on the ozone layer; how people using CFCs contribute to the problem; and how they can contribute to the solution. These messages, as well as the economic benefits of recovery and recycling, have been incorporated into a training program (Environment Canada, 1991; HRAI and EC, 1992) developed by Environment Canada and the Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI). The training program familiarizes service personnel with the Code of Practice.

Governments should continue to work with industry and trade associations to develop training programs for industry. In addition, all levels of government should cooperate in the preparation of other communications materials, such as public service announcements about how individuals can protect the ozone layer. An industry newsletter, emphasizing environmental issues and regulatory requirements, could be another effective tool.

An appropriate training program is necessary and a certificate should be issued to participants. This training program should be required across Canada to ensure a general awareness of the problem and an acceptable minimum standard of performance in actual practice of recovery and recycling.

Owners of buildings must be made aware of CFC emission problems and the need to develop and implement immediate reduction policies. Building owners must develop a strategic plan to ensure that their facilities will be able to operate after 1995.

4.5 Destruction of Chlorofluorocarbons

Environmentally safe CFC destruction technology will be required for CFCs that are either too contaminated for recycling or that are no longer needed when substitutes are marketed. An international task group, chaired by Canada, has been established under UNEP to study the status of destruction technologies for ozone-depleting substances and to make recommendations to the parties to the Montreal Protocol.

All provinces will need to examine their waste management policies and regulations to ensure that there are no obstacles to the transition from recycling to destruction when CFCs are no longer needed.

Ideally, the recovery, recycling, and reclamation infrastructure should be able to serve as a collection tool for any destruction program. Data on use and inventories of CFCs will provide basic data for future actions.

Section 5

Action Plan

Following are the major tasks that must be carried out to implement an effective recovery and recycling program across all jurisdictions in Canada, to support the prime objective of CFC emission reduction.

5.1 Task No. 1

Mandate the recovery, recycling, and reclamation of CFCs and HCFC from the following equipment during servicing:

- domestic refrigeration;
- mobile air conditioning (cars, buses, trucks, trains);
- refrigerated transportation (ships, containers, railcars, trucks);
- industrial refrigeration (major industry, industrial ice-making), arenas and curling rinks;
- commercial chillers (air conditioners);
- cold storage/food refrigeration (fish, food, vegetable freezers);
- retail refrigeration (supermarkets, fridge modules);
- heat pumps, dehumidifiers; and
- disposable containers.

Provincial regulations are probably the best approach for meeting the objectives of the National Action Plan. This is consistent with the regulatory responsibilities agreed to by the CCME. The Working Group will monitor progress on a regular basis and report to FPAC.

Recommendation

a) It is recommended that the Provinces mandate the recovery and recycling of CFCs from the equipment listed under this Task by the end of 1992.

b) As an adjunct to mandating recovery and recycling of CFCs, it is recommended that provinces and the federal government develop programs to prevent the release of CFCs and HCFCs to the atmosphere within one year after mandating recovery and recycling of CFCs. As well, particular consideration should be given to requiring that leaks be repaired before putting the system back into service and that use of nonreturnable containers be reduced and phased out.

5.2 Task No. 2

(a). Develop training programs for the service community in conjunction with industry/trade associations.

Training is essential for the success of a CFC recovery and recycling program and promotion of a high degree of compliance with CFC regulations. The following approaches may be taken:

- governments collaborate with industrial/trade associations to develop training packages and certification programs;

- governments and industry work to develop/implement communication strategies to promote training and certification programs;

- industrial/trade associations use their organization networks as well as community colleges, in combination with their regular programs, to deliver approved training courses and award certificates;

- governments require CFC equipment service personnel to obtain the appropriate training and certificate;

- governments develop and implement a program to require refrigeration/air conditioning equipment owners/users to use certified service technicians for any servicing involving recovery, and recycling; and

- governments require that all graduates from a community college refrigeration course have a recovery, recycling certificate.

Environment Canada and the HRAI have jointly developed a communication/training package consisting of: a user-oriented video; an instructor's manual; and a participant's manual. The training course, based on the Code of Practice developed by Environment Canada and aimed mainly at technical personnel who handle and service commercial/industrial systems, will be conducted through the RSES and HRAI network. A certificate, which will be valid in all provinces, will be awarded by HRAI to those who have satisfactorily completed this training course.

Environment Canada has been consulting with the Canadian Electronic and Appliance Service Association (CEASA) to develop a training course suitable for technicians who service residential systems. The training manuals developed with HRAI will be modified/revised with inputs from CEASA to make them applicable. The training course will be conducted by CEASA.

The Mobile Air Conditioning Society (MACS) has developed a Certification Training Manual for Automotive Air Conditioning Technicians (HRAI and EC, 1992). The United States Environmental Protection Agency (U.S. EPA) will develop a certification program for automobile air conditioning technicians similar to the one established by MACS. Canadian governments should consider recognizing one or more industry-approved programs.

In general, the opinion of industry is that the certification of technicians will work only if such certification is required by regulation. One approach would be to require certification for purchasing CFCs from suppliers/wholesalers for equipment servicing. Auditing for certificates will be necessary.

Recommendations

a) Environment Canada should expedite its efforts with industry associations to develop training programs, in a national context, that can be applied or used by the provinces and municipalities.

b) Recognizing that the objective is to ensure that all those servicing refrigeration and air conditioning equipment receive recovery and recycling training that is consistent with the "Code of Practice" at a minimum, provinces should ensure effective delivery of recovery, and recycling training. This may include accreditation or certification programs. These programs may include a feature

that would restrict access to the supply of CFCs for equipment servicing to companies and/or technicians who meet the provincial accreditation requirements.

c) Building and systems owners should be encouraged to ensure that only certified service people be allowed to service their equipment.

Schedule

Programs to be developed from July 1, 1991 to December 31, 1992. Delivery of training courses to be carried out from October 1991 to December 1992.

(b). Revise the "Code of Practice for the Reduction of Chlorofluorocarbon Emissions from Refrigeration and Air Conditioning Systems".

The Code of Practice has been a very useful and practical document. Its use is expected to increase significantly for industry training courses, building owners and operators use, and as a reference manual for consultants.

Developments in recovery and recycling and use of SI standards need to be incorporated along with several other additions.

Recommendation

(a) continue to use existing supply of code manuals; and

(b) revise, update, and re-issue the manual.

Schedule

The manual should be revised and printed by September 1992 or earlier if possible.

5.3 Task No. 3

Characterize the existing inventory of CFCs in Canada.

It is important to know the supply/demand curve for recovered CFC refrigerants because of Canada's commitment to phase out production and importation of virgin product by 1996. An inventory of CFCs banked in existing equipment and systems is necessary to prepare supply demand forecasts. At present, the supply and demand for CFCs as refrigerants is in a state of flux. A number of variables, such as the pace of development and market availability of substitute chemicals, will affect the continuing demand for CFC-12, and the necessary timing for a destruction capability. The inventory of major bulk quantities and installations of CFCs and HCFCs is also required for spill prevention purposes.

Market demand = virgin material + recycled material + reclaimed material + HCFCs

Market demand curves can be extracted from historical data, subtracting regulated reductions or use phaseouts, and then correcting for industrial economic activity.

Recommendation

a) It is recommended that Environment Canada proceed with a pilot study of the CFC inventory, the uncertainties of the present situation, and the possible difficulties in compiling an inventory of banked CFCs. This information is important for the development of a viable national recovery and recycling action plan.

The focus of the study would be retail refrigeration equipment using CFC-12. Based on a review of the results of the pilot study, the Working Group could proceed with characterization of the remainder of the CFC inventory.

b) An alternate choice to (a) could be the refrigerant R-502 which is used primarily for commercial coolers and freezers. Supply/demand data will help indicate any increased use of recovery, recycling, and reclamation.

Schedule

A pilot study has been completed. The full study should be completed by October, 1992.

5.4 Task No. 4

Develop appropriate standards of quality and performance for recycling equipment with industry and standards associations.

There are very few standards, specifications, or guidelines for recovery and recycling processes or "purity" requirements for recycled material in existence. Several American professional societies and institutes are developing standards. An Air-Conditioning and Refrigeration Institute (ARI) Standard and a Guideline are now in use in the United States (ARI, 1991). As they are not available in French, however, they could not be referenced in federal, Manitoba, or New Brunswick regulations. The Working Group has examined the possibility of contracting with the Canadian Standards Association (CSA) to produce and maintain a Canadian Standard in both languages. The CSA has estimated the cost of doing so to be $80 000 to $100 000. The alternative is to leave it to industry to ensure the adequacy of standards; and once established, to confirm them.

Recommendations

a) The Working Group recommends leaving it to industry to ensure the adequacy of standards for recovery and recycling, since this could probably be done through the appropriate industry associations. This will be monitored by the Working Group to ascertain whether serious problems arise or if regulatory support is needed.

b) When standards have been clearly established and accepted by industry, then governments should resolve via the Ad Hoc Working Group how best to support and affirm these.

c) The Working Group will attempt to introduce environmental concerns into existing trade standards for refrigeration equipment as they are modified by the technical committees who control them.

Schedule

Monitoring by the Working Group will be ongoing.

5.5 Task No. 5

(a). *Inform the general public of the problem and the solution.*

There is a need to keep the general public aware of what the ozone layer is; how it protects us; what substances are responsible for its depletion; and any resultant effects on human, animal, and plant life; as well as the public's role in protecting the ozone layer.

Public reaction and participation is an integral part of resolving the ozone-depletion problem. Consequently, the public should be well informed both about the issue itself and about ways to solve the problem. An informed public will be more likely to demand action.

As a first step, the federal, provincial, and local governments, industry, environmental groups, and any other applicable organizations should be surveyed to determine what information/educational packages have been prepared for the public.

The next step would be to prepare a nontechnical brochure/fact sheet that will do the following:

- explain the issue in simple terms;
- outline the problem, and its cause and effects;
- identify where ozone-depleting substances are used;
- emphasize the need to conserve, recover, recycle, and reclaim;
- identify control measures;
- summarize the action taken to date by industry and government;
- identify what the public can/should do to help;
- indicate where further information may be obtained; and
- summarize future plans and directions.

This material can be produced by the Working Group and published as a CCME fact sheet. The cost (based on other CCME fact sheets) would be about $8 000 to $10 000, depending on size, quantity, and distribution. This could be funded according to the CCME funding formula.

A third step to help consumers would be appropriate labelling on appliances to indicate what type of refrigerant is being used.

Recommendation

(a) It is recommended that the Working Group proceed with the survey to determine what information is now available.

(b) Depending on the results, proceed with the preparation of an appropriate brochure/fact sheet.

(c) Regulations should contain an appropriate labelling requirement, to avoid confusion or improper accidental mixing of refrigerant during servicing.

Schedule

Recommendation (a) - mid-1992

Recommendation (b) - fourth quarter 1992

(b). *Inform Industry*

There is a communication gap between reality and perception of several industry segments in terms of regulations, future product availability, recovery, and recycling. A newsletter directed at the industry (refrigeration and air conditioning) could correct this. Alternatively, it may be possible to use some existing trade publications. The newsletter may be issued on an as-required basis but no more than twice a year.

Recommendation

The Working Group recommends development of a newsletter or equivalent with a selected mailing list (twice a year, maximum).

Schedule

First issue	fourth quarter of 1992
Spring - summer issue	April/May
Fall - winter issue	October/November

5.6 Task No. 6

Revise government purchasing and procurement standards to stipulate recovery of CFCs and Halons, and the use of recycled CFCs and Halons, and adherence to codes of practice, etc.

Many departments and agencies at the federal, provincial, and municipal levels probably carry out operations, or are responsible for the use and servicing of equipment, buildings, and vehicles that use CFCs, Halons, and other ozone-depleting substances. This task, therefore, could be time- and labour-intensive, particularly for information gathering needed by each jurisdiction to carry it out. Initially, emphasis would be placed on recovery of CFCs, Halon, etc., then moving to the use of recycled products. Purchasing standards should require that CFCs be recovered during servicing, and standards should also provide for use of recycled refrigerant.

Because of the ultimate phaseout of CFCs and the need to convert equipment to HCFCs or HFCs where possible, surveying and data-gathering will be essential in any case.

It may be useful to systematize and standardize the information-gathering process to be used by each jurisdiction. Designing a questionnaire, or a series of questionnaires, would simplify both the requesting of information, and information provision by the user agency. This approach would also provide a degree of information consistency which would be beneficial in terms of a national plan.

The major steps in carrying out this task, for each jurisdiction, are (some steps have been initiated under the Environmental Stewardship Program in federal facilities):

- identify the major target agencies or departments from which information is required; a list of minor targets could also be developed for contact later in the process;
- request information from these target groups that would enable an assessment of the scope of operations and the quantities of systems, equipment, vehicles etc., which involve continuing use of CFCs; including manufacturer, model number, refrigerant, type of equipment, age, etc.;
- establish a clear policy and develop a strategic plan recognizing needs such as: adequate forecasting and budgeting, training, and availability of service contractors;
- analyze the information gathered to establish the primary and secondary target agencies or departments to be included in the program;
- identify the available options to approach target groups and agencies to obtain cooperation and commitment to recovery of CFCs and use of recycled product; for example, what level of management should be approached to secure an appropriate commitment to the program,

or should the approach be made at a political level, perhaps involving the "house in order" concept;

- using the most appropriate option, obtain agreement for the necessary changes in operations, revision of procurement standards, use of trained/accredited service people only, and use of codes of practice to be put in place; and

- to the extent considered appropriate or feasible, monitor the results to ascertain the reduction in CFC consumption.

While there will be benefits from using a national approach to some aspects of this task, such as a general planning scenario, each jurisdiction must be able to use approaches and methods that best suit their individual situations. The actual potential for reductions in CFC consumption may be the deciding factor in specific situations.

Recommendation

As noted previously, the associated volume of work precludes the members of the Working Group assuming complete responsibility for carrying it out. It is therefore recommended that:

a) The Working Group examine the potential for systematizing the acquisition of information from target agencies and departments, including the design of questionnaires, if appropriate;

b) The Working Group focus on motivating the involved groups to undertake this task of development of appropriate policies, strategies, and tactics for emission reduction, on a self-management-by-objectives basis.

c) The Working Group encourage networking among the various groups for mutual assistance and to provide them with consultation as required.

d) Each Working Group member obtain commitment to the program to assure that sufficient resources are assigned to carry out the task in each jurisdiction.

e) Using its information exchange capability, the Working Group establish and maintain a close follow-up on the progress and results of the activity, and report periodically to the FPAC on such progress and results.

Schedule

Implementation of programs within the various departments and agencies is estimated to require 12 to 18 months. This program will be ongoing.

5.7 Task Summary

Tasks No. 1 to No. 6 are summarized in Table 1.

Table 1 Summary of Dates and Responsibilities

No.	Title	Schedule	Responsibility	Priority
1.	Mandate Recovery Recycle, Reclaim	By end of 1992	Provinces + Environment Canada consultation	1
	Consider Prohibiting CFC Deliberate Release	By end of 1993	Provinces	
2a.	Develop Training Programs	July 1991 to Dec. 1992	Environment Canada	1
	Deliver Program	Oct. 1992 to Oct. 1993	Provinces + Industry	
	Administration	Oct. 1992 to Oct. 1993	Industry	
2b.	Revise "Code of Practice for CFC Emissions"	by Sept. 1992	Environment Canada	2
3.	Characterize Existing CFC Inventory	by Fall, 1992	Environment Canada	2
4.	Develop Equipment and Quality Standards	Ongoing	Primarily Industry plus Working Group	2
5a.	Inform General Public on Issues	Recommendation a) mid-1992: Recommendation b) fourth quarter 1992	Working Group	2
5b.	Inform Industry	First issue by Fall 1992 twice per year max.	Working Group	3
6.	Revise Government Procurement Standards to Stipulate Recovery/ Recycle	By Jan. 1993 to July 1994 then ongoing	Working Group plus all groups involved	2

PRIORITY LEGEND: 1 = MUST BE DONE
2 = HIGHLY DESIRABLE
3 = OPTIONAL

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Appendix

Uses and Applications of Chorofluorocarbons

Chlorofluorocarbons have been useful in a wide variety of industrial applications because of their low toxicity, inherent stability, and nonflammability. They are used in many applications, including: use as coolants in refrigerators and freezers; in vehicle air conditioners; as propellants in certain medicinal aerosols; as blowing agents for plastic foam products and insulation; as cleaning agents for metals and electronic equipment, and as carrier gases for sterilant used to sterilize medical instruments.

The following descriptions of the various use categories are included for background information.

Foams. Chlorofluorocarbons are used as blowing agents in the production of flexible and rigid plastic foams. In the case of flexible polyurethane foams (open cell) used in car seats, furniture, etc. the CFCs are lost in the manufacturing process. In the case of rigid foam insulation (polyurethane, polystyrene, and phenolic), the CFCs are trapped in the closed cells where they act as an insulator. The insulating properties (R value) of rigid foams are a function of the ability of the cells of the foam to trap and retain as much CFCs as possible. Very little CFC is emitted during production and most of the CFC in these foams will be retained for many years (e.g., 20 to 40).

Recovery of CFCs from rigid foams appears to be a realistic option in the near future; research and test programs are underway and some trials have been carried out. In appliances, the insulation contains four to six times more CFC than the refrigeration system.

Solvents. CFC-113 has proven useful for a wide range of solvent, degreasing, and cleaning applications. Its use has increased substantially in the last few years because of its suitability as a solvent in the electronic manufacturing sector. CFC-113 has several properties, including low toxicity, nonflammability, low surface tension, and stability, that make it attractive for use as a solvent.

Solvent emissions occur during the cleaning process, mainly from evaporation. The major short-term method for reducing such emissions is by recovery and reclamation of material for reuse. Contaminated CFC-113 remaining in cleaning baths contains grit,dust, and solder and cannot be reused without purification.

Many medium to large users of CFC-113 either have on-site solvent recovery programs in place, or are sending used solvent off-site to commercial reclamation operators. The smaller users have to be encouraged to control emissions and to recover and recycle wherever possible. Improved equipment design to increase

freeboard ratios will also be effective in reducing emissions.

Aerosols. The use of CFCs has been eliminated from most aerosol products, and is now prohibited by federal and provincial regulations with exemptions for certain essential medicinal products. The challenge remains to find replacements for all uses. Aerosols represent less than 1% of CFC consumption.

Refrigeration and Air Conditioning. Chlorofluorocarbons are used as refrigerants in air conditioning and refrigeration systems because of their low toxicity, nonreactivity, nonflammability, and thermodynamic properties. The 1988 use pattern in this sector is shown in Figure 3 of this report. Use in 1990 was approximately 50% of total CFCs in Canada (Figure 4).

Losses from air conditioners and refrigerators (including large systems) occur due to leaks when seals deteriorate. Venting losses also occur during repair and servicing and operation. In general, CFCs are not yet recovered from white goods (refrigerators, freezers, etc.) destined for disposal. Studies are under way in some cities to determine the amount of CFCs available for recovery from curbside white goods. Some recovery from large systems is now being practiced.

The following table illustrates CFC use by equipment type.

Chemical	Use
CFC-11	- large commercial air conditioning equipment, centrifugal systems
CFC-12	- mobile, domestic and commercial refrigeration/air-conditioning equipment and transportation equipment (e.g., display cases, cold storage, home refrigerators)
CFC-113	- commercial applications (limited uses mainly in centrifugal air conditioning chillers)
CFC-114	- commercial chillers (limited uses)
HCFC-22	- domestic air conditioners, transportation equipment, arenas and frozen food processing and storage
R-500 (CFC-12/HFC-152a)	- small dehumidifier systems
CFC-502 HCFC-22/CFC-115)	- commercial refrigeration (low temperature units), display cases, frozen food processing

Vehicle Air Conditioners. The market for air-conditioned vehicles is growing in Canada. Sources of CFC-12 emissions during the life cycle of vehicle air conditioners include: leak-testing during manufacturing; materials handling loss during recharging; normal leaking due to system deterioration or failure during operation; venting during service and repair; loss due to accident; and leakage after the vehicle is taken out of service. When vehicle air conditioners are serviced, the general practice is to vent the remaining charge to the atmosphere. Most CFCs used in vehicle air conditioners go to replace operating and servicing losses. Therefore, the recovery and recycling of CFCs from vehicle air conditioners is an important target.

A number of recovery and recycling units are on the market that can be used in service stations. One of the simplest solutions is to recycle the cleaned refrigerant directly back into the vehicles at the service station. The viability of recycling depends on the quality of the recycled CFCs and the level of quality control. Vehicle manufacturers may be reluctant to continue warranty coverage of the vehicle air conditioners if the recycled refrigerant is of inferior quality that may damage the air conditioner. The release of CFCs after an accident or during final disposal represents an unknown quantity. It is important to determine the viability of recovering CFCs from discarded and wrecked vehicles.

Commercial Air Conditioners and Refrigeration. Recycling programs for CFCs used in commercial refrigeration and air conditioning systems are feasible but require a number of conditions to make them effective. This includes: refrigeration units that are designed to allow safe and controlled removal of CFCs; trained service personnel; a network of qualified recyclers; and recognized product quality standards for recycled CFCs. Refrigerant gas in air conditioners, refrigerators, and freezers is contained in a virtually enclosed system. Emissions usually occur from component breakdown, during maintenance work, and from slow leaks caused by damage to seals or pipe connections. As a variety of CFCs are used by industry, products returned for recycling may be contaminated. Any recycling scheme would have to ensure that mixing did not occur. Commercial units are more likely to contain their charge of CFCs at time of disposal than are domestic units, and hence are better sources of recoverable refrigerant gases.

Domestic Air Conditioners and Refrigerators. There is a relatively small charge (110 to 170 g) of CFCs in domestic refrigerators and freezers. Domestic air conditioners use HCFC-22 and recovered CFC 12 may become contaminated with recovered HCFC-22 unless care is taken. Because of the small charge of CFCs, on-site recovery will require specialized methods and equipment. However, where units are brought into a central service shop, recovery, and subsequent recycling can be undertaken.

There is currently little incentive for service personnel to recover the small quantities involved. As most discarded domestic refrigerators and freezers eventually enter the waste stream, the amount of CFCs that may be recovered is potentially quite large. As the supply of CFCs dwindles, recovery will become more important. A more efficient process would involve recovery at the waste collection site.